What Is Claimed Is:

1. A method for estimating a porosity and a saturation in a subsurface reservoir, comprising:

determining a plurality of mathematical relationships relating a plurality of fundamental physical parameters that govern elastic wave propagation in the subsurface reservoir to the porosity and the saturation in the subsurface reservoir;

forward modeling a plurality of seismic attributes using the mathematical relationships to derive a plurality of conditional probability density functions for the seismic attributes;

applying a Bayesian inversion to the conditional probability density functions for the seismic attributes to derive a joint probability density function for the porosity and the saturation in the subsurface reservoir; and

integrating the joint probability density function for the porosity and the saturation to derive a probability density function for the porosity and a probability density function for the saturation.

2. The method of claim 1, further comprising mapping the probability density function for the porosity to a set of observed seismic attributes to generate an estimate for the porosity for the set of observed seismic attributes.

3. The of method of claim 2, wherein the probability density function for the porosity is mapped to the observed seismic attributes using a maximum a posteriori estimator.

4. The of method of claim 2, further comprising generating one of a standard deviation and one or more quintiles for the estimate for the porosity.

5. The method of claim 1, further comprising mapping the probability density function for the saturation to a set of observed seismic attributes to generate an estimate for the saturation for the set of observed seismic attributes.

6. The of method of claim 5, wherein the probability density function for the saturation is mapped to the observed seismic attributes using a maximum a posteriori estimator.

7. The of method of claim 5, further comprising generating one of a standard deviation and one or more quintiles for the estimate for the saturation.

8. The method of claim 1, wherein the step of forward modeling comprises:
randomly drawing a plurality of porosity and saturation values;
simulating the seismic attributes from the porosity and saturation values; and
deriving the conditional probability density functions for the seismic attributes.

9. The method of claim 1, wherein the fundamental physical parameters comprise a bulk modulus (K), a shear modulus (G) and a bulk density (ρ).

10. The method of claim 1, wherein the mathematical relationships are determined using rock physics.

11. The method of claim 1, wherein the seismic attributes are forward modeled using stochastic rock physics.

12. A computer readable medium containing a program which, when executed, performs an operation, comprising:

determining a plurality of mathematical relationships relating a plurality of fundamental physical parameters that govern elastic wave propagation in the subsurface reservoir to the porosity and the saturation in the subsurface reservoir;

forward modeling a plurality of seismic attributes using the mathematical relationships to derive a plurality of conditional probability density functions for the seismic attributes;

applying a Bayesian inversion to the conditional probability density functions for the seismic attributes to derive a joint probability density function for the porosity and the saturation in the subsurface reservoir; and

integrating the joint probability density function for the porosity and the saturation to derive a probability density function for the porosity and a probability density function for the saturation.

13. The computer readable medium of claim 12, wherein the operation further comprises mapping the probability density function for the porosity to a plurality of observed seismic attributes to generate an estimate for the porosity.

14. The computer readable medium of claim 12, wherein the operation further comprises mapping the probability density function for the saturation to a plurality of observed seismic attributes to generate an estimate for the saturation.

15. The computer readable medium of claim 12, wherein the step of forward modeling comprises:

randomly drawing a plurality of porosity and saturation values;

simulating the seismic attributes from the porosity and saturation values; and

deriving the conditional probability density functions for the seismic attributes.

16. The computer readable medium of claim 12, wherein the fundamental physical parameters comprise a bulk modulus (K), a shear modulus (G) and a bulk density (ρ).

17. The computer readable medium of claim 12, wherein the mathematical relationships are determined using rock physics.

18. The computer readable medium of claim 12, wherein the seismic attributes are forward modeled using stochastic rock physics.

19. A method for estimating a porosity and a saturation in a subsurface reservoir, comprising:

determining a plurality of mathematical relationships relating a plurality of fundamental physical parameters that govern elastic wave propagation in the subsurface reservoir to the porosity and the saturation in the subsurface reservoir;

forward modeling a plurality of seismic attributes using the mathematical relationships to derive a plurality of conditional probability density functions for the seismic attributes;

applying a Bayesian inversion to the conditional probability density functions for the seismic attributes to derive a joint probability density function for the porosity and the saturation in the subsurface reservoir;

integrating the joint probability density function for the porosity and the saturation to derive a probability density function for the porosity and a probability density function for the saturation;

mapping the probability density function for the porosity to a set of observed seismic attributes to generate an estimate for the porosity for the set of observed seismic attributes; and

mapping the probability density function for the saturation to a set of observed seismic attributes to generate an estimate for the saturation for the set of observed seismic attributes.

20. The method of claim 19, wherein the fundamental physical parameters comprise a bulk modulus (K), a shear modulus (G) and a bulk density (ρ).